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RULISON SITE CLEAN-UP REPORT

by

Eberline Instrument Corporation  
Santa Fe, New Mexico 87501

February 27, 1973

D R A F T

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Project Manager's Report

COPY

Project RULISON Cleanup Report

On-Site Radiological Safety Services

by

EBERLINE INSTRUMENT CORPORATION

Santa Fe, New Mexico 87501

Submitted for Publication

(date to be inserted)

Work Performed under Contract

AT(26-1)-294

with the

United States Atomic Energy Commission

Nevada Operations Office

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ABSTRACT

Eberline Instrument Corporation was assigned under Contract AT(26-1)-294 to furnish radiological support for the cleanup of Project Rulison site. Work at the site commenced on July 10, 1972 and was completed July 25, 1972. Three EIC employees participated. Labor for the cleanup was furnished by Austral Oil Company.

The purpose of this operation was to remove from the site all equipment and material not needed for possible future gas production. This was accomplished, and the radiological condition of the site was documented.

Participants received no radiation exposure due to performance of cleanup work at the site.

## RULISON SITE CLEANUP REPORT

### Introduction

Eberline Instrument Corporation provided radiological safety and measurement support for cleanup operations at Project Rulison site near Rifle, Colorado during the period July 10, 1972 through July 25, 1972.

The isotope of interest in this cleanup was tritium. No other radioisotopes, except naturally occurring, were detected.

A total of 426 soil samples were collected for tritium analysis from 192 sampling points. Concentrations of tritium in soil moisture ranged from not detectable to 47,000 pCi/ml. Concentrations of tritium per weight of soil ranged from not detectable to 20,000 pCi/g.

A total of 11 vegetation samples were collected. An aliquot of moisture from each was analyzed for unbound tritium. Concentrations ranged from 4.5 to 170 pCi/ml ( $H_2O$ ) and from 2.8 to 150 pCi/g (wet sample). Part of each sample was dried and then oxidized to obtain an aliquot containing tritium bound in the sample. Concentrations of this bound tritium ranged from less than 8.3 to 190 pCi/ml (water from oxidation) and from less than 0.8 pCi/g to 5.3 pCi/g (wet sample).

No tritium was detected in samples of site spring water and site air moisture. Tritium analysis was by liquid scintillation. The term "not detectable" means less than three standard deviations of background, or 1 pCi/ml of the sample.

Two shipments of tritium contaminated waste were made to Nuclear Engineering Company for disposal. The first was a 3000-gallon tanker truck containing 0.69 Ci of tritium in liquids. The second was 32 packages of solids and six 55-gallon steel drums of liquid, an estimated 73 mCi of tritium.

In addition to tritium in site soil and vegetation, not more than 0.03 Ci of tritium were left at the site. This amount is contained in solidified sludge left in the bottom of three water holding tanks.

Items of equipment and material found to be clean, and those decontaminated, were removed from the site if not needed for possible future gas production. Certain items such as the wellhead Christmas tree, separator, and storage tanks which are internally contaminated were left also for future use, as was the well logging equipment. The storage tanks containing contaminated sludge were locked and posted with appropriate signs. The fenced site area was conspicuously posted with no trespassing signs.

Areas of higher tritium concentrations in soil resulted from known spills rather than from flare fallout during production tests.

Concentrations in soil recorded in pCi/g are extremely variable due to high variability of percentage moisture in the soil. The recorded concentration in pCi/ml of soil moisture is a much better measurement for tritium in soil and is much more practicable.

#### Equipment

A radiation measurement trailer was transported to the site. This trailer contained a liquid scintillation system, a gamma spectrometry system, and a gross alpha-beta counting system. It served further as an office and as a central point of operations.

A sample preparation area was juryrigged in the Rulison re-entry wellhead shack.

The following types of portable survey instruments were used:

Eberline E-400 with HP-177 probe --  
a low range beta-gamma detection  
instrument

Eberline PRM-4 with HP-210 probe --  
a pulse rate meter with a probe window  
of less than 7 mg/cm<sup>2</sup>

Eberline PRM-5 with SPA-2 probe --  
a pulse rate meter with a 1" x 2" crystal  
detector

A supply of supplementary equipment and material such as glassware,  
tools, plastic containers, and anti-contamination clothing was furnished  
by EIC.

#### Personnel Monitoring

All personnel participating in the cleanup wore thermoluminescent  
dosimeters (TLD) throughout the operation. Fourteen badges were  
issued. These were read in Santa Fe subsequent to the cleanup. No ex-  
posure was recorded. All dosimetry records were submitted for storage  
in the AEC dosimetry system at the Nevada Test Site.

Paper anti-contamination coveralls were worn by personnel while  
transferring contaminated liquid among the storage tanks and from the  
tanks to the tanker truck.

Baseline urine samples were collected prior to initiation of work.  
Samples were collected again upon completion of the cleanup. These  
samples were analyzed for tritium down to 10 pCi/ml by liquid scintillation  
analysis -- none was detected.

#### Decontamination and Disposal of Equipment and Material

Holding areas were established to segregate 'clean' from con-  
taminated items of equipment and material. A release log was started  
to describe each item and to record its radiological condition. Each  
item was surveyed with a PRM-4 (HP-210 probe) and was swiped to check  
for removable contamination. All items released to unrestricted use

had a survey reading of background and a  $100 \text{ cm}^2$  swipe count of less than 1000 disintegrations per minute.

The general approach was to first survey and swipe the equipment and material that had not been in contact with contaminated liquids or gases, for example, the Western Slope gas line and the clean water supply line. After verifying that these were not contaminated, they were moved to the 'clean' holding area.

The next step was to disassemble pipe lines and equipment known to have been in contact with contaminants. Care was taken to drain and contain all liquids obtained from this disassembly operation. Items that could not be economically decontaminated because of fixed lime or rust scale were surveyed and swiped for documentation and were moved to the holding area for contaminated material. Small pipes and solid waste were placed inside large pipes. The ends of pipes serving as containers were closed with welded plates. Outside surfaces were surveyed and swiped to verify that these surfaces were not contaminated.

The old pipe rack drip pan was used as a decontamination pad. De-contamination was accomplished with saturated steam and Steamzall, a TURCO product. The inside areas of pipes were reached with a long steam lance. Items that could be economically decontaminated were moved into the pipe rack drip pan, decontaminated, and then moved into the wellhead drip pan for survey and swipe checking. When decontamination was satisfactory (background survey and less than 1000 dpm/ $100 \text{ cm}^2$  removable contamination) they were moved to the 'clean' holding area. Water generated by the decontamination procedure was contained in 55-gallon steel drums.

On July 20, 1972 liquids held in the three water storage tanks and the two hydrocarbon storage tanks were pumped into the Nuclear Engineering

Company's tanker truck for shipment to their burial ground at Beatty, Nevada. The water tanks were pumped with a vacuum type pump until only two to three inches of sludge remained in the bottom of each. This sludge was solidified with five bags of Bentonite per tank. The hydrocarbon tanks were drained completely dry. The outside surfaces of the tanks were not contaminated. They were closed and plugged, and left in place for possible future use. The tanker truck shipment was 3000 gallons, totaling 0.69 Ci of tritium.

On July 22, 1972, 32 packages of solid contaminated waste and six 55-gallon drums of liquid were loaded on Nuclear Engineering Company's flatbed truck for shipment to their burial ground at Beatty, Nevada. Each drum was contained in a Nuclear Engineering furnished DOT approved container known as a "Paper Tiger." The outside surfaces of all containers were not contaminated. This shipment contained an estimated 73 mCi of tritium.

In addition to the three water tanks and two hydrocarbon tanks, the wellhead Christmas tree, the separator, the wellhead-to-separator gas line, the wire line rig, and the dead weight pressure measuring system were left on the site, all presumed to be contaminated internally -- the wire, of course, externally.

Equipment and material cleared for unrestricted use and held in the 'clean' holding area was removed from the site to an Austral storage yard in Rifle, Colorado. Uncontaminated trash was buried on the site. The drip pans, emplacement well shack, and re-entry wellhead shack, all uncontaminated, were left in place for possible further use. Other miscellaneous shacks were torn down and removed pursuant to release procedures.

### Soil Sampling

The soil sampling program was the critical path in the site cleanup plan. Therefore, it was started as early as possible and was given special emphasis throughout the cleanup period.

A square grid of soil sampling points was laid out on magnetic cardinal headings using the site entrance gate post as the zero and primary reference point. Ten- and 20-foot squares were used depending on the area use history and on the probability of soil contamination. Further, squares were sometimes distorted to sample points of special interest such as storage tank, pipe line runs, the separator, and drip pan areas or to avoid obstructions such as cement pads. While the flare stack was located on the square grid system, the area around it was sampled on a radial grid referenced to the stack. This radial grid was used here because contaminated fallout originated from the stack as a center and because a radial grid was used post-flare, making a comparison more meaningful. A total of 192 sampling points were located. Most of these were sampled at one- and 12-inch depths. Fourteen points were sampled at one-, 12-, 24-, and 48-inch depths. Two points were sampled at multiple depths to 96 and 132 inches respectively. A few were sampled at selected depths for various reasons. A total of 426 soil samples were collected for tritium analysis.

Each sample was weighed wet, as collected, and was then dried in an electric oven for 15 hours at 180 degrees centigrade. After drying the sample was again weighed. Wet and dry weights were recorded for each sample and the percentage of moisture was calculated. Where possible, a 5 ml aliquot of soil moisture was distilled from each sample. The aliquots were analyzed by liquid scintillation for tritium concentration

in pCi/ml. From this the concentration in pCi/g was calculated. Results of these analyses are shown in Table I and on the attached drawings, No. 1 A & B.

Upon completion of the last production test on April 23, 1971 soil on arcs around the flare stack was sampled and analyzed for tritium. The results of this sampling program are provided in Table 2 and on drawings 2 A & B to augment the samples taken on radial coordinates during the cleanup operation and to permit comparison where the same locations were sampled.

Eight randomly located soil samples were collected for pulse height analysis by gamma spectrometry. No radioisotopes other than naturally occurring were detected.

#### Vegetation Samples

A vegetation sample was taken at each cardinal point on a 500-foot and a 1000-foot arc around the flare stack. Additional vegetation samples were collected at site grid point N-14, W-2 and stack grid points 030°, 5' and 120°, 40'. These samples were collected because of the leak from a water storage tank, the close proximity to the flare stack, and the area of highest concentration indicated by the post-flare sampling respectively.

Vegetation samples were analyzed in Albuquerque after the cleanup operation. Each sample was weighed wet and dry. An aliquot of moisture was distilled from the sample. An aliquot of dry sample was oxidized and condensed to obtain the bound tritium. The results of these analyses are shown in Table 3.

### Site Air Sampling

Filtered air samples were taken for three days, a dry ice freeze trap was run for two days -- samples were collected daily from both. The sampling point was on the drillback pad approximately 95 feet from the wellhead on a bearing of 005 degrees. In addition, a freeze-out sample was collected from the steam used in decontamination. No radioactivity was detected in the filtered air samples and no tritium was detected in the freeze-out air moisture samples.

### Site Water Samples

Prior to completion of the cleanup water samples were taken from each of two local springs at the site. One was located just off of the Southeast corner of the drillback pad, the other was on the upper side of the road about 300 yards down hill from the pad. Both samples were analyzed by liquid scintillation. No tritium was detected.

### Sludge Sample

A sample of the sludge left in the bottom of the three water holding tanks was taken before the solidifying agent (Bentonite) was added. This sample was analyzed for tritium in Albuquerque after the cleanup. Since the sample was in hydrocarbon form, it was oxidized and its condensed water vapor was analyzed by liquid scintillation. The tritium concentration was 15,000 pCi/g of sludge. Total volume left on-site in the tanks was not more than 441 gallons. Assuming a density of 1.2, the total amount of tritium in solidified sludge that remains stored at the site is not more than 0.03 Ci.

### Conclusions

In general, areas of higher tritium concentrations resulted from known spills -- not from the flare fallout. For example, the number 3 tank valve which froze and broke may have leaked slowly and seeped into the ground for perhaps several weeks. The depth to which tritium was observed (11 feet) indicate the source was available for a fairly long period of time.

The pCi/g readings are extremely variable due to the high variability of percentage moisture in the soil. The percentage of moisture varied with the type soil -- clay, shale, gravel, humus, etc. The pCi/ml value for moisture was much more stable and predictable, and therefore, is the better measurement for tritium in soil.

### Recommendations

To minimize tritium contamination of soil during future gas stimulation events, contaminated water handling equipment should be designed specifically for high-integrity water containment.

Future soil contamination guidelines should be based on tritium concentration per volume of soil moisture rather than on concentration per weight of soil.

TABLE I  
Tritium in Rulison Soil Moisture

<u>Grid Coordinate</u> <sup>(1)</sup>	<u>Sampling Depth (in.)</u> <sup>(4)</sup>	<u>pCi/ml</u> <sup>(2)</sup>	<u>pCi/g (soil)</u> <sup>(3)</sup>
N-0, E-2 .....	1 .....	14 .....	0.01
N-0, E-2 .....	12 .....	ND .....	ND
N-1, E-2 .....	1 .....	3.2 .....	0.007
N-1, E-2 .....	12 .....	14 .....	5.2
N-2, E-2 .....	1 .....	ND .....	ND
N-2, E-2 .....	12 .....	13 .....	2.9
N-3, E-.7 .....	1 .....	ND .....	ND
N-3, E-.7 .....	12 .....	5.2 .....	1.1
N-3, E-2 .....	1 .....	ND .....	ND
N-3, E-2 .....	12 .....	ND .....	ND
N-4, E-.7 .....	1 .....	3.8 .....	0.4
N-4, E-.7 .....	12 .....	ND .....	ND
N-4, E-2 .....	1 .....	ND .....	ND
N-4, E-2 .....	12 .....	ND .....	ND
N-5, E-.7 .....	1 .....	4.3 .....	0.5
N-5, E-.7 .....	12 .....	4.9 .....	0.95
N-5, E-2 .....	1 .....	ND .....	ND
N-5, E-2 .....	12 .....	ND .....	ND
N-6, E-.7 .....	1 .....	ND .....	ND
N-6, E-.7 .....	12 .....	ND .....	ND
N-6, E-2 .....	1 .....	290 .....	23
N-6, E-2 .....	12 .....	4.0 .....	0.8
N-7, E-.7 .....	1 .....	ND .....	ND
N-7, E-.7 .....	12 .....	5.9 .....	2.0
N-7, E-2 .....	1 .....	3.9 .....	0.1
N-7, E-2 .....	12 .....	8.3 .....	1.8
N-8, E-.7 .....	1 .....	ND .....	ND
N-8, E-.7 .....	12 .....	ND .....	ND
N-8, E-2 .....	1 .....	ND .....	ND
N-8, E-2 .....	12 .....	ND .....	ND
N-9, E-.7 .....	1 .....	ND .....	ND
N-9, E-.7 .....	12 .....	ND .....	ND

(1) Cardinal coordinates referenced to entrance gate post-scale:  
1 unit equals 10 feet. Radial coordinates are in degrees and  
feet referenced to flare stack.

(2) Concentrations are rounded to two significant figures

(3) Idem

(4) Sampling depth increments are 1", i.e., 1" is from 0 to 1", 12"  
is from 11" to 12", etc.

TABLE I  
Tritium in Rulison Soil Moisture  
Page 2

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
N-9, E-2	1	33	5.8
N-9, E-2	12	4.2	0.9
N-10, E-.7	1	6.1	0.68
N-10, E-.7	12	ND	ND
N-10, E-2	1	2.8	0.08
N-10, E-2	12	100	24
N-11, E-2	1	190	2.8
N-11, E-2	12	4.1	0.9
N-11.2, E-.2	1	310	25
N-11.2, E-.2	12	38	6.0
N-11.4, E-0	6	2400	1300
N-11.8, E-0	24	850	510
N-11.8, E-0	60	7800	4400
N-11.9, E-2.8	1	11	2.3
N-11.9, E-2.8	12	33	6.9
N-11.9, E-3.3	1	110	24
N-11.9, E-3.3	12	93	22
N-12, E-.7	1	600	62
N-12, E-.7	12	920	320
N-12, E-2	1	21	1.0
N-12, E-2	12	ND	ND
N-12.5, E-0	1	300	34
N-12.5, E-0	12	120	15
N-12.7, E-0	6	150	81
N-12.7, E-2.8	1	44	10
N-12.7, E-2.8	12	ND	ND
N-12.7, E-3.3	1	21	8.3
N-12.7, E-3.3	12	11	4.7
N-13, E-0	12	73	41
N-13, E-0	60	51	24
N-13, E-.7	1	87	9.3
N-13, E-.7	12	200	49
N-13, E-2	1	51	2.4
N-13, E-2	12	2.9	0.6
N-13, W-3	1	57	27
N-13, W-3	12	13	6.2

TABLE I  
Tritium in Rulison Soil Moisture  
Page 3

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
N-13.7, E-.1 .....	1 .....	10,000 .....	1400
N-13.7, E-.1 .....	12 .....	20,000 .....	5600
N-13.7, E-.1 .....	24 .....	21,000 .....	5800
N-13.7, E-.6 .....	1 .....	2700 .....	150
N-13.7, E-.6 .....	12 .....	5100 .....	1600
N-13.7, E-.6 .....	24 .....	4700 .....	1400
N-14, E-0 .....	1 .....	4700 .....	1400
N-14, E-0 .....	12 .....	3300 .....	1800
N-14, E-2 .....	1 .....	22 .....	0.3
N-14, E-2 .....	12 .....	3.3 .....	0.7
N-14.2, E-.7 .....	1 .....	8600 .....	1500
N-14.2, E-.7 .....	12 .....	29,000 .....	6500
N-14.2, E-.7 .....	24 .....	35,000 .....	11,000
N-14.2, E-.7 .....	36 .....	34,000 .....	19,000
N-14.2, E-.7 .....	48 .....	27,000 .....	7300
N-14.2, E-.7 .....	60 .....	26,000 .....	14,000
N-14.2, E-.7 .....	72 .....	18,000 .....	9600
N-14.2, E-.7 .....	96 .....	8000 .....	4500
N-14.2, E-.7 .....	108 .....	9700 .....	2300
N-14.2, E-.7 .....	120 .....	5600 .....	1400
N-14.2, E-.7 .....	132 .....	3300 .....	600
N-14, W-2 .....	1 .....	110 .....	49
N-14, W-2 .....	12 .....	51 .....	7.7
N-14, W-4 .....	1 .....	16 .....	7.3
N-14, W-4 .....	12 .....	4.4 .....	2.1
N-14.2, E-0 .....	6 .....	3100 .....	1700
N-15, E-1 .....	1 .....	650 .....	290
N-15, E-1 .....	12 .....	1400 .....	670
N-15, E-2 .....	1 .....	300 .....	140
N-15, E-2 .....	12 .....	11 .....	6.0
N-15, W-3 .....	1 .....	420 .....	22
N-15, W-3 .....	12 .....	130 .....	16
N-16, E-1 .....	1 .....	270 .....	120
N-16, E-1 .....	12 .....	260 .....	140
N-16, E-2 .....	1 .....	26 .....	11
N-16, E-2 .....	12 .....	5.3 .....	2.6

TABLE I  
Tritium in Rulison Soil Moisture  
Page 4

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
N-17, E-1 .....	1 .....	160 .....	75
N-17, E-1 .....	12 .....	17,000 .....	6000
N-16.7, E-2 .....	1 .....	36 .....	0.9
N-16.7, E-2 .....	12 .....	ND .....	ND
N-17.8, E-2 .....	1 .....	710 .....	370
N-17.8, E-2 .....	12 .....	330 .....	170
N-18, E-1 .....	1 .....	11 .....	5.3
N-18, E-1 .....	12 .....	80 .....	41
N-19, E-1 .....	1 .....	25 .....	12
N-19, E-1 .....	12 .....	22 .....	11
N-19, E-2 .....	1 .....	10 .....	4.5
N-19, E-2 .....	12 .....	15 .....	7.1
N-20, E-1 .....	1 .....	8.4 .....	3.9
N-20, E-1 .....	12 .....	280 .....	130
N-20, E-2 .....	1 .....	71 .....	34
N-20, E-2 .....	12 .....	10 .....	4.6
N-21, E-1 .....	1 .....	44 .....	20
N-21, E-1 .....	12 .....	73 .....	30
N-21, E-2 .....	1 .....	56 .....	25
N-21, E-2 .....	12 .....	ND .....	ND
N-22, E-1 .....	1 .....	25 .....	12
N-22, E-1 .....	12 .....	100 .....	43
N-22, E-2 .....	1 .....	8.4 .....	3.9
N-22, E-2 .....	12 .....	23 .....	12
N-23, E-1 .....	1 .....	15 .....	6.8
N-23, E-1 .....	12 .....	290 .....	140
N-23, E-2 .....	1 .....	6.6 .....	3.2
N-23, E-2 .....	12 .....	3.4 .....	1.7
N-24, E-1 .....	1 .....	59 .....	26
N-24, E-1 .....	12 .....	69 .....	33
N-24, E-2 .....	1 .....	450 .....	220
N-24, E-2 .....	12 .....	6.9 .....	3.6
N-24, W-2 .....	72 .....	14 .....	2.1
N-25, E-1 .....	1 .....	16 .....	7.1
N-25, E-1 .....	12 .....	15 .....	7.3
N-25, E-2 .....	1 .....	18 .....	8.7
N-25, E-2 .....	12 .....	22 .....	11

TABLE I  
Tritium in Rulison Soil Moisture  
Page 5

<u>Grid Coordinate<sup>(1)</sup></u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
N-26, E-1 .....	1 .....	15 .....	6.4
N-26, E-1 .....	12 .....	39 .....	19
N-26, E-2 .....	1 .....	31 .....	14
N-26, E-2 .....	12 .....	34 .....	17
N-27, E-1 .....	1 .....	44 .....	23
N-27, E-1 .....	12 .....	51 .....	24
N-28, E-1 .....	1 .....	390 .....	180
N-28, E-1 .....	12 .....	160 .....	86
000°, 20' .....	1 .....	180 .....	44
000°, 20' .....	12 .....	290 .....	94
000°, 40' .....	1 .....	43 .....	3.2
000°, 40' .....	12 .....	14 .....	1.1
030°, 20' .....	1 .....	32 .....	8.5
030°, 20' .....	12 .....	53 .....	18
030°, 40' .....	1 .....	22 .....	1.1
030°, 40' .....	12 .....	ND .....	ND
060°, 20' .....	1 .....	10 .....	3.5
060°, 20' .....	12 .....	14 .....	4.3
060°, 40' .....	1 .....	100 .....	12
060°, 40' .....	12 .....	11 .....	0.75
090°, 20' .....	1 .....	84 .....	4.9
090°, 20' .....	12 .....	27 .....	8.6
090°, 40' .....	1 .....	32 .....	3.0
090°, 40' .....	12 .....	4.8 .....	0.55
120°, 20' .....	1 .....	74 .....	7.3
120°, 20' .....	12 .....	45 .....	6.0
120°, 20' .....	24 .....	290 .....	40
120°, 20' .....	48 .....	81 .....	42
120°, 40' .....	1 .....	18 .....	2.0
120°, 40' .....	12 .....	15 .....	1.4

(1) Cardinal coordinates referenced to entrance gate post - scale:  
1 unit equals 10 feet. Radial coordinates are in degrees and  
feet referenced to flare stack.

TABLE I  
Tritium in Rulison Soil Moisture  
Page 6

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
120°, 40'	24	140	28
120°, 40'	48	380	73
120°, 60'	1	60	8.4
120°, 60'	12	27	3.6
120°, 60'	24	290	160
120°, 60'	48	290	61
150°, 20'	1	28	2.3
150°, 20'	12	3.6	0.6
150°, 40'	1	37	5.4
150°, 40'	12	21	3.1
210°, 20'	1	170	7.1
210°, 20'	12	220	48
210°, 40'	1	11	0.46
210°, 40'	12	ND	ND
240°, 20'	1	1100	82
240°, 20'	12	4700	1400
240°, 40'	1	60	7.6
240°, 40'	12	16	2.0
270°, 20'	1	16	5.3
270°, 20'	12	53	17
270°, 40'	1	22	0.93
270°, 40'	12	ND	ND
300°, 3'	1	230	100
300°, 3'	12	780	400
300°, 3'	24	3300	1900
300°, 3'	36	3800	820
300°, 3'	48	5700	1300
300°, 3'	60	6400	3200
300°, 3'	72	4400	2500
300°, 3'	84	2900	1400
300°, 3'	96	2700	1300
300°, 20'	1	400	115
300°, 20'	12	450	150
300°, 20'	24	3900	520
300°, 20'	48	2500	520

TABLE I  
Tritium in Rulison Soil Moisture  
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<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
300°, 40'	1	42	2.1
300°, 40'	12	8.6	1.2
330°, 20'	1	350	100
330°, 20'	12	600	180
330°, 40'	1	65	4.1
330°, 40'	12	17	1.5
S-1, E-1	1	6.5	0.04
S-1, E-1	12	ND	ND
S-1, E-2	1	10	0.006
S-1, E-2	12	ND	ND
S-1, E-3	1	ND	ND
S-1, E-3	12	ND	ND
S-2, W-.7	1	ND	ND
S-2, W-.7	12	7.3	1.2
S-3, E-0	1	1500	810
S-3, E-0	12	66	11
S-3, E-2	1	ND	ND
S-3, E-2	12	ND	ND
S-3.8, E-1.4	1	ND	ND
S-3.8, E-1.4	12	ND	ND
S-5, E-0	1	ND	ND
S-5, E-0	12	ND	ND
S-5, E-2	1	ND	ND
S-5, E-2	12	ND	ND
S-5, E-4	1	ND	ND
S-5, E-4	12	20	3.4
S-5.7, W-2	1	200	7.5
S-5.7, W-2	12	2.9	0.56
S-7, E-0	1	ND	ND
S-7, E-0	12	ND	ND
S-7, E-2	1	ND	ND
S-7, E-2	12	ND	ND
S-7, E-4	1	ND	ND
S-7, E-4	12	ND	ND
S-7, E-6	1	70	29
S-7, E-6	12	ND	ND

TABLE I  
Tritium in Rulison Soil Moisture  
Page 8

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
S-7, E-8	1	770	13
S-7, E-8	12	ND	ND
S-7, E-10	1	91	2.3
S-7, E-10	12	ND	ND
S-7, E-12	1	6.7	0.17
S-7, E-12	12	ND	ND
S-7.5, W-2.7	1	43	0.37
S-7.5, W-2.7	12	ND	ND
S-8, W-1.5	1	ND	ND
S-8, W-1.5	12	ND	ND
S-9, E-0	1	ND	ND
S-9, E-0	12	ND	ND
S-9, E-2	1	100	41
S-9, E-2	12	ND	ND
S-9, E-4	1	ND	ND
S-9, E-4	12	ND	ND
S-9, E-6	1	ND	ND
S-9, E-6	12	ND	ND
S-9, E-8	1	ND	ND
S-9, E-8	12	ND	ND
S-9, E-10	1	130	4.5
S-9, E-10	12	ND	ND
S-9, E-12	1	110	2.1
S-9, E-12	12	ND	ND
S-9.4, W-3.4	1	3900	32
S-9.4, W-3.4	12	230	25
S-10, W-1.5	1	ND	ND
S-10, W-1.5	12	ND	ND
S-10.3, E-10.1	1	ND	ND
S-10.3, E-10.1	12	ND	ND
S-10.3, E-10.1	24	ND	ND
S-10.3, E-10.1	48	ND	ND
S-11, E-0	1	610	11
S-11, E-0	12	ND	ND
S-11, E-2	1	ND	ND
S-11, E-2	12	ND	ND
S-11, E-4	1	62	0.98
S-11, E-4	12	ND	ND

TABLE I  
Tritium in Rulison Soil Moisture  
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<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
S-11, E-6	1.....	ND	ND
S-11, E-6	12.....	ND	ND
S-11, E-8	1.....	ND	ND
S-11, E-8	12.....	ND	ND
S-11, E-10	1.....	ND	ND
S-11, E-10	12.....	ND	ND
S-11, E-12	1.....	ND	ND
S-11, E-12	12.....	ND	ND
S-11, E-14	1.....	ND	ND
S-11, E-14	12.....	ND	ND
S-11.2, W-4	1.....	280	21
S-11.2, W-4	12.....	ND	ND
S-11.7, E-3.1	1.....	ND	ND
S-11.7, E-3.1	12.....	ND	ND
S-11.7, E-8.7	1.....	ND	ND
S-11.7, E-8.7	12.....	ND	ND
S-11.7, E-8.7	24.....	ND	ND
S-11.7, E-8.7	48.....	ND	ND
S-12, E-1	1.....	ND	ND
S-12, E-1	12.....	ND	ND
S-12, E-5	1.....	18	0.2
S-12, E-5	12.....	ND	ND
S-12, W-1.5	1.....	3.8	0.2
S-12, W-1.5	12.....	ND	ND
S-12.4, E-3.8	1.....	ND	ND
S-12.4, E-3.8	12.....	ND	ND
S-12.8, E-1.9	1.....	ND	ND
S-12.8, E-1.9	12.....	ND	ND
S-12.8, E-1.9	24.....	ND	ND
S-12.8, E-1.9	48.....	ND	ND
S-13, E-0	1.....	ND	ND
S-13, E-0	12.....	ND	ND
S-13, E-6	1.....	ND	ND
S-13, E-6	12.....	ND	ND
S-13, E-8	1.....	14	0.32
S-13, E-8	12.....	84	6.3
S-13, E-10	1.....	11	0.01
S-13, E-10	12.....	ND	ND

TABLE I  
Tritium in Rulison Soil Moisture  
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<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
S-13, E-12 .....	1.....	ND .....	ND
S-13, E-12 .....	12.....	ND .....	ND
S-13, E-14 .....	1.....	ND .....	ND
S-13, E-14 .....	12.....	ND .....	ND
S-13.1, E-7.3 .....	1.....	ND .....	ND
S-13.1, E-7.3 .....	12.....	ND .....	ND
S-13.1, E-7.3 .....	24.....	ND .....	ND
S-13.1, E-7.3 .....	48.....	ND .....	ND
S-13.1, W-4.8 .....	1.....	690 .....	290
S-13.1, W-4.8 .....	12.....	ND .....	ND
S-13.2, E-4.5 .....	1.....	ND .....	ND
S-13.2, E-4.5 .....	12.....	ND .....	ND
S-13.5, E-2.8 .....	1.....	ND .....	ND
S-13.5, E-2.8 .....	12.....	ND .....	ND
S-13.9, E-5.2 .....	1.....	ND .....	ND
S-13.9, E-5.2 .....	12.....	ND .....	ND
S-14, E-.8 .....	1.....	ND .....	ND
S-14, E-.8 .....	12.....	ND .....	ND
S-14, W-3.4 .....	1.....	120 .....	1.1
S-14, W-3.4 .....	12.....	45 .....	8.5
S-14.2, E-3.4 .....	1.....	ND .....	ND
S-14.2, E-3.4 .....	12.....	12 .....	1.6
S-14.2, E-3.4 .....	24.....	ND .....	ND
S-14.2, E-3.4 .....	48.....	ND .....	ND
S-14.6, E-5.9 .....	1.....	20 .....	0.1
S-14.6, E-5.9 .....	12.....	ND .....	ND
S-14.6, E-5.9 .....	24.....	ND .....	ND
S-14.6, E-5.9 .....	48.....	ND .....	ND
S-14.7, E-1.6 .....	1.....	ND .....	ND
S-14.7, E-1.6 .....	12.....	ND .....	ND
S-15, E-12 .....	1.....	26 .....	0.03
S-15, E-12 .....	12.....	ND .....	ND
S-15, E-14 .....	1.....	ND .....	ND
S-15, E-14 .....	12.....	ND .....	ND
S-15, W-1.8 .....	1.....	76 .....	1.4
S-15, W-1.8 .....	12.....	1400.....	210

TABLE I  
Tritium in Rulison Soil Moisture  
Page 11

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
S-15.4, E-2.2 .....	1.....	ND .....	ND
S-15.4, E-2.2 .....	12.....	ND .....	ND
S-15.4, E-5 .....	1.....	55 .....	0.4
S-15.4, E-5 .....	12.....	ND .....	ND
S-15.4, E-5 .....	24.....	ND .....	ND
S-15.4, E-5 .....	48.....	ND .....	ND
S-15.4, E-6.6 .....	1.....	480 .....	7.6
S-15.4, E-6.6 .....	12.....	ND .....	ND
S-15.4, E-8 .....	1.....	ND .....	ND
S-15.4, E-8 .....	12.....	12 .....	2.1
S-16, E-0 .....	1.....	ND .....	ND
S-16, E-0 .....	12.....	ND .....	ND
S-16.1, E-3 .....	1.....	520 .....	16
S-16.1, E-3 .....	12.....	ND .....	ND
S-16.2, E-4 .....	1.....	48 .....	1.3
S-16.2, E-4 .....	12.....	ND .....	ND
S-16.2, E-4 .....	24.....	ND .....	ND
S-16.2, E-4 .....	48.....	ND .....	ND
S-16.6, E-6.6 .....	1.....	8.5 .....	0.2
S-16.6, E-6.6 .....	12.....	5.3 .....	0.5
S-16.6, E-6.6 .....	24.....	8.9 .....	0.9
S-16.6, E-6.6 .....	48.....	ND .....	ND
S-16.6, E-8 .....	1.....	5.9 .....	0.24
S-16.6, E-8 .....	12.....	5.7 .....	0.3
S-17, E-10 .....	1.....	ND .....	ND
S-17, E-10 .....	12.....	ND .....	ND
S-17, E-12 .....	1.....	ND .....	ND
S-17, E-12 .....	12.....	46 .....	2.4
S-17, E-14 .....	1.....	190 .....	54
S-17, E-14 .....	12.....	ND .....	ND
S-17.1, E-1.8 .....	1.....	89 .....	1.2
S-17.1, E-1.8 .....	12.....	ND .....	ND
S-18, E-6.5 .....	1.....	11 .....	0.1
S-18, E-6.5 .....	12.....	14 .....	1.3
S-18.2, E-3.5 .....	1.....	270 .....	56
S-18.2, E-3.5 .....	12.....	ND .....	ND
S-19, E-8 .....	1.....	11 .....	0.67
S-19, E-8 .....	12.....	ND .....	ND

TABLE I  
Tritium in Rulison Soil Moisture  
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<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
S-19, E-9	1.....	ND	ND
S-19, E-9	12.....	ND	ND
S-19, E-9	24.....	ND	ND
S-19, E-9	48.....	ND	ND
S-19, E-10	1.....	ND	ND
S-19, E-10	12.....	50	4.9
S-19, E-12	1.....	ND	ND
S-19, E-12	12.....	5.8	0.28
S-19, E-14	1.....	ND	ND
S-19, E-14	12.....	ND	ND
S-19.3, E-5.1	1.....	58	1.4
S-19.3, E-5.1	12.....	11	2.3
S-20, E-12	1.....	12	0.56
S-20, E-12	12.....	15	0.39
S-20.4, E-6.8	1.....	ND	ND
S-20.4, E-6.8	12.....	ND	ND
S-21, E-14	1.....	19	0.43
S-21, E-14	12.....	ND	ND
S-21.5, E-8.5	1.....	300	2.2
S-21.5, E-8.5	12.....	ND	ND
S-22.5, E-10.2	1.....	130	0.52
S-22.5, E-10.2	12.....	ND	ND
S-23.2, E-17	1.....	9.4	4.1
S-23.2, E-17	12.....	ND	ND
S-23.5, E-12	1.....	13	0.54
S-23.5, E-12	12.....	4.1	0.71
S-23.8, E-15.3	1.....	32	1.2
S-23.8, E-15.3	12.....	ND	ND
S-24.6, E-13.7	1.....	47,000	20,000
S-24.6, E-13.7	12.....	860	140
S-24.6, E-17	1.....	36	0.39
S-24.6, E-17	12.....	19	3.2
S-25.4, E-15.4	1.....	1400	22
S-25.4, E-15.4	12.....	1700	235

TABLE 2  
Tritium in Rulison Soil Moisture  
Post-Production Test -- April 23, 1971

<u>Grid Coordinate<sup>(1)</sup></u>	<u>Sampling Depth (in.)<sup>(4)</sup></u>	<u>pCi/ml<sup>(2)</sup></u>	<u>pCi/g (soil)<sup>(3)</sup></u>
000°, 20'	1	390	100
000°, 20'	3	980	250
000°, 20'	6	480	120
000°, 20'	0 to 2	940	250
000°, 20'	2 to 4	540	130
000°, 20'	4 to 6	260	68
000°, 20'	6 to 8	220	55
000°, 20'	8 to 10	260	62
000°, 20'	10 to 12	210	50
000°, 40'	1	1700	420
000°, 40'	0 to 2	400	94
000°, 40'	2 to 4	510	120
000°, 40'	4 to 6	750	180
000°, 40'	6 to 8	660	150
000°, 40'	8 to 10	580	130
000°, 40'	10 to 12	510	110
000°, 80'	1	180	44
000°, 80'	0 to 2	350	88
000°, 80'	2 to 4	510	110
000°, 80'	4 to 6	500	100
000°, 80'	6 to 8	370	88
000°, 80'	8 to 10	280	57
000°, 80'	10 to 12	210	46
000°, 120'	1	650	230
000°, 120'	0 to 2	410	110
000°, 120'	2 to 4	340	71
000°, 120'	4 to 6	290	68
000°, 120'	6 to 8	320	76
000°, 120'	8 to 10	250	62
000°, 120'	10 to 12	210	49

(1) Radial coordinates are in degrees and feet referenced to flare stack

(2) Concentrations are rounded to two significant figures

(3) Idem

(4) Sampling depth increments, when not otherwise indicated, are 1", i.e., 1" is from 0 to 1", 6" is from 5" to 6", etc.

Table 2  
 Tritium in Rulison Soil Moisture  
 Post-Production Test  
 Page 2

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
000°, 200'	1	130	43
000°, 500'	1	39	9.8
000°, 500'	6	20	3.4
000°, 1000'	1	19	4.1
000°, 1000'	6	12	2.7
030°, 20'	1	510	130
030°, 40'	1	140	34
030°, 200'	1	79	18
030°, 80'	1	97	23
030°, 120'	1	180	42
060°, 20'	1	760	210
060°, 40'	1	300	80
060°, 80'	1	120	20
060°, 120	1	300	120
060°, 200'	1	70	24
090°, 20'	1	300	76
090°, 40'	1	160	44
090°, 80'	1	130	36
090°, 120'	1	260	82
090°, 200'	1	46	16
090°, 500'	1	2400	630
090°, 500'	6	53	14
090°, 1000'	1	11	3.2
090°, 1000'	6	13	3.3
120°, 20'	1	3800	970
120°, 40'	1	2100	550
120°, 80'	1	1400	370
120°, 120'	1	190	56
120°, 200'	1	380	55
150°, 20'	1	130	29
150°, 40'	1	710	160
150°, 80'	1	200	54
150°, 120'	0 to 1	210	65
150°, 120'	1 to 2	180	53
150°, 120'	2 to 4	220	62
150°, 120'	4 to 8	290	87

Table 2  
 Tritium in Rulison Soil Moisture  
 Post-Production Test  
 Page 3

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
150°, 120'	8 to 12	420	110
150°, 120'	12 to 16	340	84
150°, 120'	16 to 20	130	25
150°, 120'	20 to 24	79	16
150°, 120'	24 to 28	75	15
150°, 120'	28 to 32	110	19
150°, 120'	32 to 36	110	22
150°, 120'	36 to 40	87	19
150°, 120'	40 to 44	62	14
150°, 120'	44 to 48	59	13
150°, 200'	1	190	34
180°, 5'	1	7400	1600
180°, 5'	6	3000	700
180°, 20'	1	2800	620
180°, 40'	1	170	33
180°, 80	1	410	85
180°, 120'	1	1500	300
180°, 200'	1	79	8.7
180°, 500'	1	1900	650
180°, 500'	6	6	1.1
180°, 1000'	1	57	14
180°, 1000'	6	6	1.2
210°, 20'	1	540	130
210°, 40'	1	240	50
210°, 80'	1	110	33
210°, 120'	1	100	23
210°, 200'	1	84	10
240°, 14'	1	2800	730
240°, 20'	1	680	180
240°, 40'	1	270	62
240°, 80'	1	130	28
240°, 120'	1	34	7
240°, 200'	1	77	8.1
270°, 20'	1	1600	410
270°, 40'	1	240	68
270°, 80'	1	240	60
270°, 120'	1	230	53

Table 2  
 Tritium in Rulison Soil Moisture  
 Post-Production Test  
 Page 4

<u>Grid Coordinate</u>	<u>Sampling Depth (in.)</u>	<u>pCi/ml</u>	<u>pCi/g (soil)</u>
270°, 200'	1	37	10
270°, 500'	1	8	1.2
270°, 500'	6	26	5.8
270°, 1000'	1	12	2.6
270°, 1000'	6	27	5.6
300°, 20'	1	1200	310
300°, 40'	1	200	54
300°, 80'	1	340	76
300°, 120'	1	88	21
300°, 200'	1	140	32
330°, 20'	1	1900	500
330°, 20'	3	5700	1400
330°, 20'	6	6800	1600
330°, 20'	1	1400	350
330°, 20'	2	790	200
330°, 20'	2 to 4	1900	480
330°, 20'	4 to 8	4500	1100
330°, 20'	8 to 12	3800	900
330°, 20'	12 to 16	3100	710
330°, 20'	16 to 24	1900	440
330°, 20'	24 to 28	860	200
330°, 20'	28 to 32	190	43
330°, 20'	32 to 36	250	57
330°, 20'	36 to 40	40	8.1
330°, 20'	40 to 44	280	60
330°, 20'	44 to 48	250	47
330°, 40'	1	160	44
330°, 80'	1	230	56
330°, 120'	1	270	76
330°, 200'	1	210	60

TABLE 3  
Tritium in Vegetation

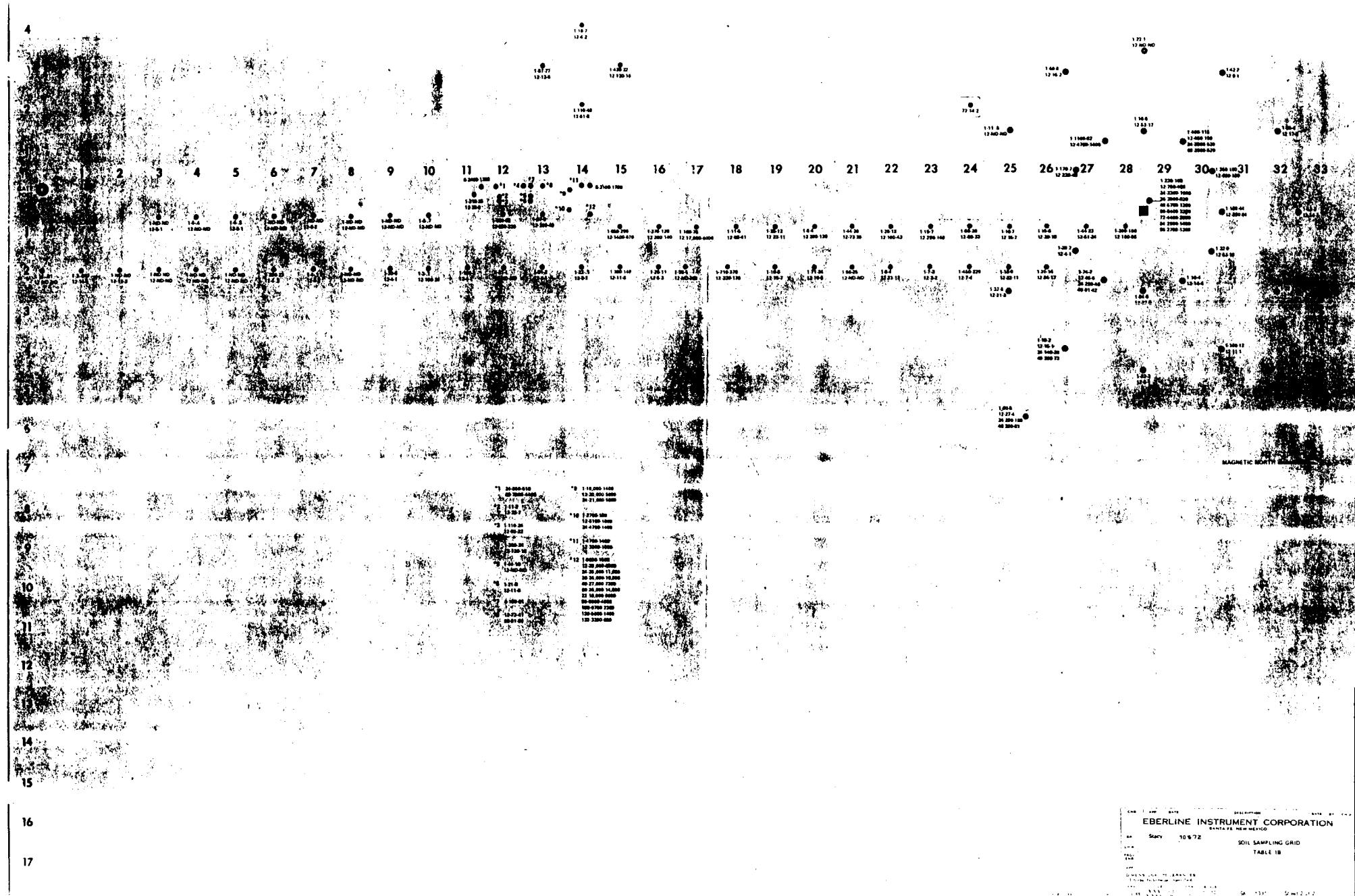
Sampling point (referenced to flare stack)	Dry/Wet ratio	Unbound (1)		Bound (2)		Total pCi/g (wet)
		pCi/ml(H <sub>2</sub> O)	pCi/g (wet)	pCi/ml(H <sub>2</sub> O) (water from oxidation)	pCi/g (wet)	
000°, 500'	0.38	7.0	4.3	<31	<1.7	≈ 4.3
000°, 1000'	0.42	7.2	2.8	<8.3	<1.4	≈ 2.8
090°, 500'	0.23	4.5	3.5	<32	<1.5	≈ 3.5
090°, 1000'	0.30	8.1	5.7	<33	<1.1	≈ 5.7
180°, 500'	0.22	75	58	<16	<0.9	≈ 58
180°, 1000'	0.25	7.1	5.3	<11	<0.8	≈ 5.3
270°, 500'	0.19	5.5	4.5	<28	<0.8	≈ 4.5
270°, 1000'	0.25	7.5	5.6	<14	<1.0	≈ 5.6
030°, 5'	0.13	170	150	190	5.3	160
120°, 40'	0.27	64	47	97	3.6	51
*N-14, W-2	0.22	150	120	41	2.3	120

\*West of tank #3, referenced to entrance gate post

(1) Unbound is tritium in water that was removable by drying the sample in an electric oven for 16 hours.

(2) Bound is tritium converted to water form by oxidizing the dried sample.





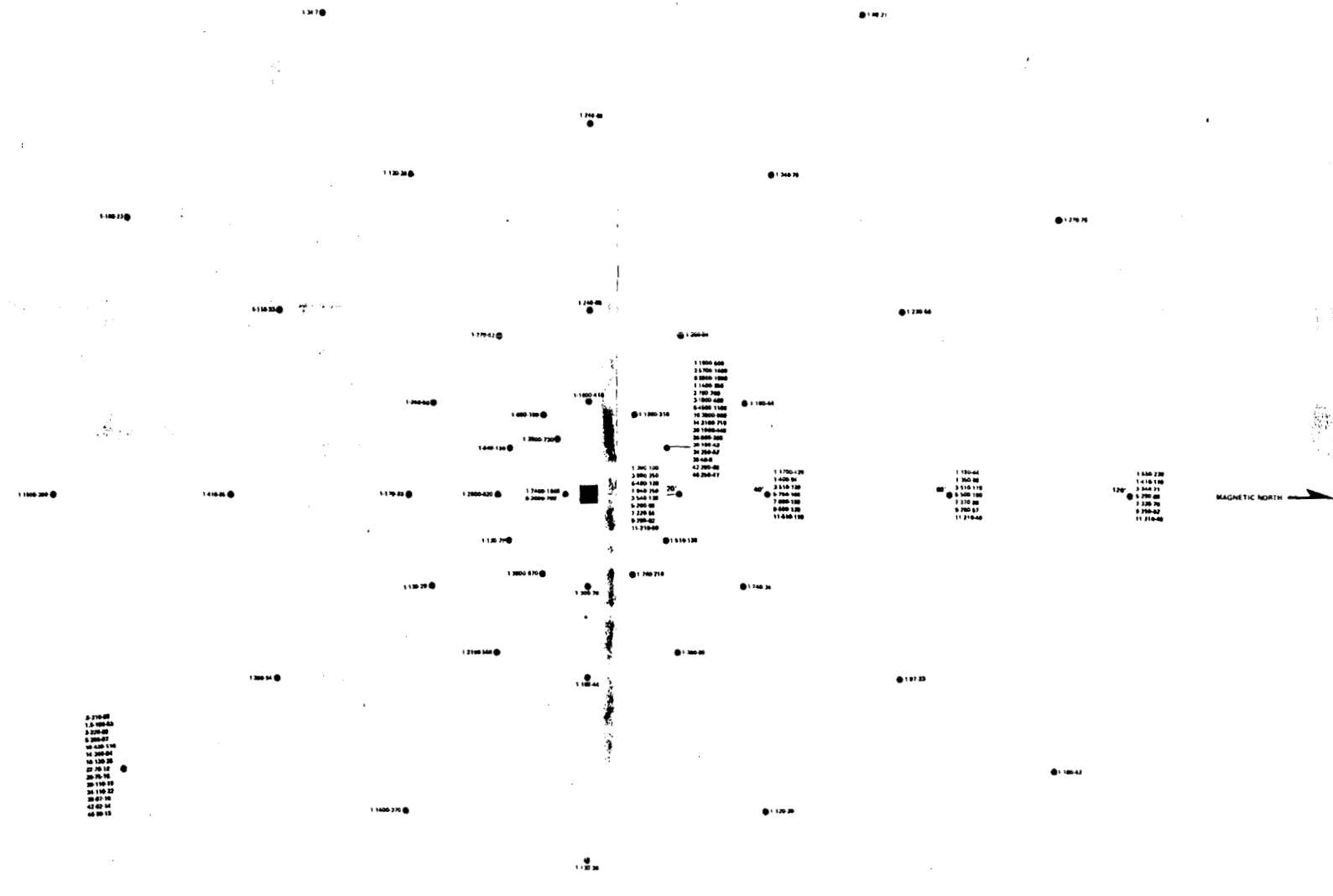
### NOTES.

## I. SYMBOLS

- FLARE STACK
  - RE ENTRY WELLHEAD
  - ND - NON DETECTABLE

## 1 CODING EXAMPLE





**EBERLINE INSTRUMENT CORPORATION**  
SANTA FE, NEW MEXICO